

# **Novel Superhard Materials and Nanostructured Diamond Composites for Multiple Industrial Applications**

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## **Objective:**

*Harder, Tougher, Last “Forever”*

Superhard & Superabrasive Materials for Industrial Applications  
such as drilling, cutting, grinding, *etc.*

## **Approach:**

High Energy Ball Milling Preparation for Nanostructure

High Pressure and High Temperature Synthesis/Sintering

## **Commercialization:**

More than a billion dollar markets in the making of drill bits,  
machinery tools, and energy & environmental savings

# Achievements

- Novel  $\text{BC}_2\text{N}$ ,  $\text{BC}_4\text{N}$  materials in single ternary phases; *second hardest* ( $H_v = 62\sim 68$  GPa) after diamonds
- Nanostructured Diamond-SiC Composites with 50% increase in *fracture toughness* ( $K_{Ic} \rightarrow 12 \text{ MPa}\cdot\text{m}^{1/2}$ )
- $\text{B}_6\text{O}$  Single Crystals as hard as cubic boron nitride with much higher *thermal stability* ( $T_c \sim 1800$  K)

# Future Works

- Hybrid diamond composites with nanocrystals and nano-/amorphous matrix
- Reduce  $P$ - $T$  synthesis/sintering conditions by systematic selection of catalysts
- EDM'able (*Electric Discharge Machining-able*) products to make desired shapes
- Nanotube-reinforcements to greatly enhance the fracture toughness
- Materials HARDER than diamonds !!!